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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/918,115	07/30/2001	Michael Graetzel	16090-23	2594

7590 10/10/2003
Clifford W. Browning
Woodard, Emhardt, Naughton, Moriarty & McNett
Bank One Center/Tower
111 Monument Circle, Suite 3700
Indianapolis, IN 46204

EXAMINER

HU, SHOUXIANG

ART UNIT PAPER NUMBER

2811

DATE MAILED: 10/10/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/918,115

Applicant(s)

GRAETZEL ET AL.

Examiner

Shouxiang Hu

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 23 July 2003.
- 2a) ☒ This action is FINAL. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1 and 6-17 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1 and 6-17 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Claim Objections

1. Claims 1 and 5-17 are objected to because of the following informalities and/or defects:
 2. The term of "a n-type" recited in claim 1 should read as: --an n-type--.
 3. The term of "and of a sensitizing semiconductor" also recited in claim 1 should read as: --and a sensitizing semiconductor--.
 4. Still in claim 1, the phrase of "a polarity of individual point-contact junctions between said quantum dots and said n-type semiconductor on one hand and said quantum dots and said p-type semiconductor on the other hand" fails to definitely define what are the individual point-contact junctions. In view of the specification, it should read as: -- a polarity of individual point-contact junctions between said quantum dots and said n-type semiconductor and between said quantum dots and said p-type semiconductor--.
 5. In claim 17, the term of "layered heterojunction" lacks sufficient antecedent basis. Appropriate correction is required.

Claim Rejections - 35 USC § 112

6. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

7. Claims 1 and 6-17 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Full support is not found in the original disclosure for the combination of the subject matters that the p-n heterojunction of instant invention is consisted of an n-type semiconductor, a p-type semiconductor and a sensitizing semiconductor, and that the sensitizing semiconductor is located only at an interface between the n-type and p-type semiconductors. It is apparent in page 7 of the 7-21-03 amendment, applicant indents to use the term of "consisting of" (as recited in claim 1) to exclude any non-quantum dot sensitizing semiconductor in the entirety of the heterojunction of the instant invention. However, it also inappropriately exclude any presence of the sensitizing semiconductor at any positions other than the interface between the n-type and p-type semiconductors, which is not fully supported by the original disclosure. According Figs. 1 and 2 of the disclosure, the entirety of the heterojunction not only includes sensitizing semiconductor (quantum dots 7) located at the interface between the n-type semiconductor (6) and the p-type semiconductor (8), but also includes sensitizing semiconductor (quantum dots 7) located between different portions of the n-type semiconductor (see the sensitizing semiconductor (quantum dots 6) between the n-type particles 6 in Fig. 2).

Claim Rejections - 35 USC § 102

8. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

9. Claims 1, 6-8 and 13-15, insofar as being in compliance with 35 U.S.C. 112, are rejected under 35 U.S.C. 102(b) as being anticipated by Siebentritt et al. ("Siebentritt"; 14th European Photovoltaic Solar Energy Conference, Barcelona, Spain, 30 June-4 July 1997, pages 1823-1826; of Record).

Siebentritt discloses a solid state sensitized solar cell having a p-n heterojunction (Figs. 1 and 2); comprising: an electron conductor (an n-type semiconductor made of solid state TiO₂, with nanocrystalline and a large band gap); a hole conductor (a p-type semiconductor made of inorganic solid state CuI); a transparent first electrode (SnO₂:F); a second electrode ("metal"); and a CdS sensitizing semiconductor between the electron and hole conductors.

It is noted that the CdS sensitizing semiconductor in Siebentritt inherently comprises individual quantum-dot particles adsorbed at the surface of the electron conductor, because Siebentritt further discloses that the chemically deposited CdS sensitizing semiconductor permeates the finer structure of the porous TiO₂ structure (see section 3.3, on page 1826). Furthermore, it is noted that Siebentritt also discloses that the CdS sensitizing semiconductor is formed through the same method as described in Weller et al. (or, Vogel et al. ("Vogel"; Chemical Physics Letters, V174,

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N3&4, 9 November 1990, pages 241-246; of record)), with the number of the repeating times of the dipping process including a number as low as 20 (see the upper left column on page 1824 of Siebentritt). And, according to Vogel, the resulting CdS sensitizing semiconductor comprises individual particles of quantum dots, even with the dipping process being repeated to as high as 30 times (with the size of individual quantum-dot particles being up to 200 Angstroms; see the abstract, section 3, and Fig. 1D in Vogel). Therefore, the resulting CdS sensitizing semiconductor in Siebentritt inherently comprises individual particles of quantum dots adsorbed at the surface of the electron conductor. Thus, the solid state sensitized solar cell of Siebentritt inherently comprises individual point-contact p-n heterojunctions.

Claim Rejections - 35 USC § 103

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

11. Claim 10, insofar as being in compliance with 35 U.S.C. 112, is rejected under 35 U.S.C. 103(a) as being obvious over Siebentritt et al. ("Siebentritt"; 14th European Photovoltaic Solar Energy Conference, Barcelona, Spain, 30 June-4 July 1997, pages 1823-1826; of Record) in view of Thelakkat et al. ("Thelakkat"; Synthetic-Metals (Switzerland), Vol. 102, No. 1-3, p. 1125-8, June 1999).

The disclosure of Siebentritt is discussed as applied to claims 1, 4-8, 13-15 and 17 above.

Although Siebentritt does not expressly disclose that the hole conductor can also be made of a polymer, one of ordinary skill in the art would readily recognize that a hole conductor can also be formed of a polymer, as evidenced in Thelakkat (see the hole conductive polymer TPD in Fig. 5); and that in general organic semiconductor materials tend to be mechanically flexible and tend to be made with a simplified process and reduced cost, compared with inorganic one.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the solar cell of Siebentritt with the hole conductor being made of a polymer, as taught in Thelakkat, so that a solar cell with improved flexibility, simplified process and/or reduced cost would be achieved.

12. Claims 9, 11 and 12, insofar as being in compliance with 35 U.S.C. 112, are rejected under 35 U.S.C. 103(a) as being obvious over Siebentritt et al. ("Siebentritt"; 14th European Photovoltaic Solar Energy Conference, Barcelona, Spain, 30 June-4 July 1997, pages 1823-1826; of Record) in view of Bach et al ("Bach"; Nature, V395, 8 October 1998, pages 583,585; of record).

The disclosure of Siebentritt is discussed as applied to claims 1, 4-8, 13-15 and 17 above.

Although Siebentritt does not expressly disclose that the hole conductor can also be made of an organic OMeTAD, one of ordinary skill in the art would readily recognize

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that organic OMeTAD is an art-recognized hole conductor for solar cells, as evidenced in Bach (see the abstract); and that in general organic semiconductor materials tend to be mechanically flexible and tend to be made with a simplified process and reduced cost, compared with inorganic one.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the solar cell of Siebentritt with the hole conductor being made of an organic OMeTAD, as taught in Bach, so that a solar cell with improved flexibility, simplified process and/or reduced cost would be achieved.

13. Claim 16, insofar as being in compliance with 35 U.S.C. 112, is rejected under 35 U.S.C. 103(a) as being obvious over Siebentritt et al. ("Siebentritt"; 14th European Photovoltaic Solar Energy Conference, Barcelona, Spain, 30 June-4 July 1997, pages 1823-1826; of Record) in view of Kay et al. ("Kay"; 5,525,440).

The disclosure of Siebentritt is discussed as applied to claims 1, 4-8, 13-15 and 17 above.

Although Siebentritt does not expressly disclose that the cell can further comprise a dense semiconductor layer between the first electrode and the heterojunction, Kay teaches to form a photo cell (Fig. 1) comprising a dense semiconductor layer (3; a non-porous TiO₂) between a first electrode (2A) and the cell junction portion (4-6) for providing a desired diffusion barrier therebetween.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the dense semiconductor layer of Kay into

the solid state sensitized photovoltaic cell of Siebentritt, so that a photovoltaic cell with a desired diffusion barrier would be obtained.

14. Claim 17, insofar as being in compliance with 35 U.S.C. 112, is rejected under 35 U.S.C. 103(a) as being obvious over Siebentritt et al. ("Siebentritt"; 14th European Photovoltaic Solar Energy Conference, Barcelona, Spain, 30 June-4 July 1997, pages 1823-1826; of Record) in view of Vogel et al. ("Vogel"; Chemical Physics Letters, V174, N3&4, 9 November 1990, pages 241-246; of record).

The disclosure of Siebentritt is discussed as applied to claims 1, 4-8, 13-15 and 17 above.

Although Siebentritt does not expressly disclose that the deposition treatment for the quantum dot particles can be performed 2-9 times, Vogel teaches that sensitizing particles with deposition treatment (dipping process) performed 5 times have very small size and lead to higher incident photon to current efficiency (IPCE), compared to the one with higher dipping-process repeating times (see Figs. 1-4).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the solar cell of Siebentritt with the deposition treatment for the sensitizing particles being performed 5 times, per the teachings of Vogel, so that a solar cell with high IPCE would be achieved.

Response to Arguments

15. Applicant's arguments filed on January 13, 2003 have been fully considered but they are not persuasive.

Applicant's main arguments include that the prior art does not teach the claimed invention because the newly amended claims recites the term "consisting of", which excludes the presence of any clustered or aggregated sensitizing semiconductor in the recited p-n heterojunctions. However, such arguments are not particularly relevant here, because the relevant subject matters added in the newly amended claims are not fully supported in the original disclosure, as explained in the claim rejections under 35 U.S.C. 112 set forth above in this Office action.

Applicant's other arguments, insofar as being in compliance with 35 U.S.C. 112, have been adequately addressed in the previous Office action.

Conclusion

16. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the

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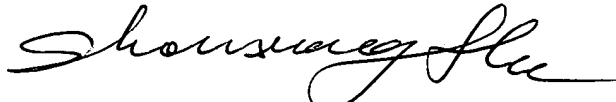
shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shouxiang Hu whose telephone number is (703) 306-5729. The examiner can normally be reached on Monday through Thursday, 7:30 AM to 6:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie C. Lee can be reached on (703) 308-1690. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

SH
October 8, 2003


SHOUXIANG HU
PRIMARY EXAMINER